West Virginia University Libraries
3 0802 100896138 8

EVANSDALE LIBRARY
WEST VIRGINIA
UNIVERSITY

RECEIVED
MAY 18 1981
EVANSDALE LIBRARY
WEST VIRGINIA UNIVERSITY

West Virginia University Library
This book is due on the date indicated below.

SEP 29 1981
OCT 29 1982
JAN 5 1986
MAY 31 2003

Digitized by the Internet Archive
in 2010 with funding from
Lyrasis Members and Sloan Foundation

http://www.archive.org/details/automationofburl463coll

The Automation of Burley Tobacco Barn Ventilating Doors

DEC 13 1961
U.S.D.A.

Bulletin 463
June 1961

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

THE AUTHORS

The authors of **The Automation of Burley Tobacco Barn Ventilating Doors** are: Edmond B. Collins, Instructor and Assistant in Agricultural Engineering; Harold F. Ross, Assistant Agronomist; and Virgil Flesher, former Assistant Professor of Agricultural Engineering and Assistant Agricultural Engineer.

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE, FORESTRY, AND HOME ECONOMICS
A. H. VANLANDINGHAM, DIRECTOR
MORGANTOWN

The Automation of Burley Tobacco Barn Ventilating Doors

EDMOND B. COLLINS, HAROLD F. ROSS and VIRGIL FLESHER

Introduction

The automation of the burley tobacco curing process is of great importance not only to the producers in West Virginia, but to the growers throughout the tobacco-producing areas of the United States. This automation is essential in order to reduce the large number of man hours required for curing the burley crop and to produce a better quality product. It has been estimated that the annual losses occurring in the tobacco crop from the time it is housed for curing until it is sold amounts to $20 million in Kentucky, $5 million in Tennessee, and one-half million dollars in West Virginia. Uncontrollable temperatures and relative humidities, resulting in houseburn and dark tobacco, are the main contributing factors to these losses.

During the past several decades many advancements have been made in the development of new disease-resistant varieties of tobacco, insecticides, fertilizers, etc.; however, there have been but few major advancements in the curing process. Techniques and design of burley tobacco curing structures are, with few exceptions, the same as existed in the early 1900's. As other agricultural processes are being mechanized and electronically controlled, the tobacco curing processes are lagging behind, still employing hand-labor techniques.

Investigation

The basic burley tobacco curing structure utilizes, where possible, natural ventilation. Series of doors, equally spaced around the outside of the structure, provide entrances for air movement through the curing barn from the windward to the leeward side. The number of ventilating doors is dependent upon the size of the curing structure, but usually there are 100 or more doors per structure. The Burley Tobacco Workers Conference recommends that 1/3 to 1/2 of the sides of the tobacco barn be ventilating doors.

The conditions required for proper curing of tobacco are very critical. Relative humidity levels should average between 65 and 70 per cent for each curing period for optimum quality of tobacco, while the temperature level average should be between 60 and 90° F. for the same period during the curing process. [1]

The above recommended levels of temperature and humidity are, in part, maintained by the proper manipulation of the ventilating doors. The doors must be adjusted to counteract temperature and humidity changes as they occur within the curing area and the incoming air. If the humidity and temperature levels change frequently, the ventilating doors must be adjusted often. This results in considerable use of manpower. In a normal day six to eight adjustments of the ventilating doors will be required.

Figure 1 shows the conventional technique for adjusting the ventilating doors. Many of the burley tobacco barns have split-level doors, as shown, therefore requiring one man to make two passes on each side of the curing structure to open or close all the doors. In a normal size barn, four or more man hours per day would be required to check curing conditions and to properly adjust the ventilating doors to meet these requirements.

If the opening and closing of the ventilating doors could be accomplished in a few minutes or less, a considerable saving in time and energy would result. In this investigation, three levels of mechanization were studied:

1. Manually operated door linkage.
2. Motor operated door linkage, manual switching.
3. Motor operated door linkage, electronic controlled, i.e., temperature and relative humidity controlled.

Analysis

The first step in the automation of the ventilating doors was the design of a mechanical linkage connecting a group of adjacent doors, Figure 2. By use of a push-pull lever, several doors could be opened or closed simulatenously, thus reducing labor requirements for each individual

[1] Jeffrey, R.N., The Relation of Curing Conditions to Quality in Burley Tobacco, Kentucky Agricultural Experiment Station, University of Kentucky, Bulletin 496, December 1946.

Figure 1 – Conventional technique for regulating burley tobacco barn doors.

door adjustment. Manual determination of temperature and humidity are still necessary before corrective adjustment of the ventilating system can be made.

The cost of installing this linkage control system will vary according to supplies on hand, but the investment to the farmer should average between $.90 and $1.00 per door if all the materials for construction are purchased on the retail market.

Detailed plans for the construction techniques can be found in the appendix.

The second step in the automation program of the tobacco barn ventilating doors consists of electrically controlling the opening and closing operation. Figure 3 shows the completed installation with the ventilating doors fully mechanized.

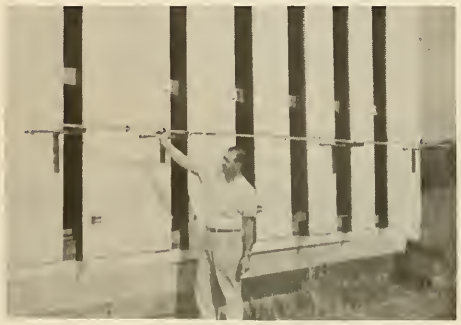


Figure 2–Manually operated linkage, ventilating doors of the burley tobacco curing barn.

Complete details for the construction of the motorized installation can be found in the appendix. By employing a manual reversing switch and using an electric motor to provide power to operate and control the action of the doors, a quick and efficient means is available for ventilating door adjustment.

Limiting switches placed in the power circuit of the electric motor will stop the motor operation when the doors are fully open or closed unless the power to the motor itself is switched off manually. By employing this motorized control on the ventilating mechanisms, the doors can be properly adjusted in a matter of seconds after the temperature and relative humidity of the curing air has been determined.

The cost of installing this system will vary according to the supplies on hand. Expected materials cost should be about $50.00 per motorized control. Each automatic control is capable of operating 50 to 70 ventilating doors with power requirements of 1/6 horsepower.

In the third step of the mechanization program, the ventilating doors are fully automatic. A designed electronic circuit, see appendix, preset at the desired temperature and humidity levels, automatically adjusts the ventilating doors as the ambient conditions vary from the desired conditions. The master control panel for this automatic system is shown in Figure 4.

This phase of the mechanization has completely eliminated the manpower requirement in the ventilating door operation. The electronic control circuit

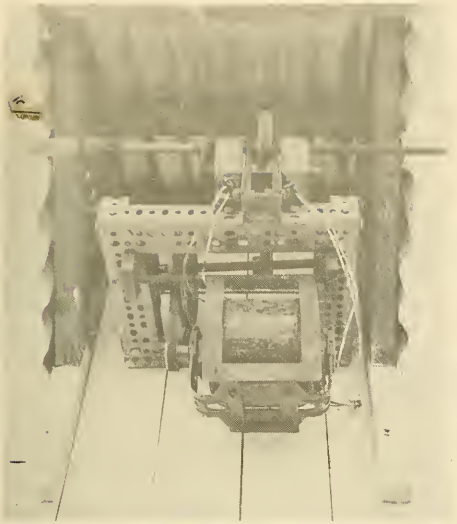


Figure 3– A – Automatic ventilating door control, burley tobacco curing barn.

Figure 3–B

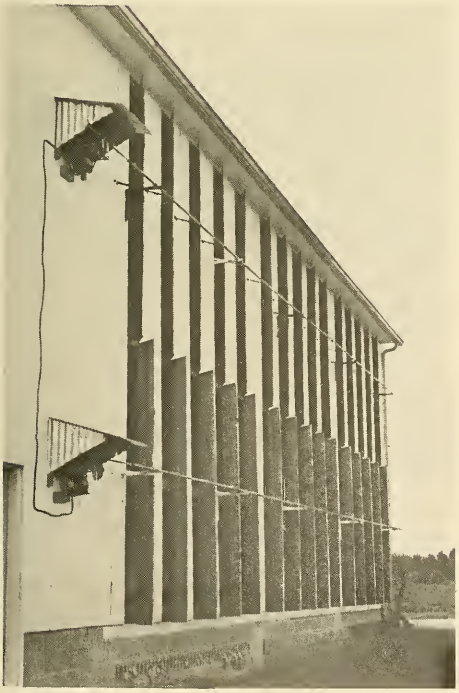


Figure 3–C

has various internal capabilities and can be adjusted to meet the necessary requirements. The circuit can be altered to control the operation of the doors based on the following temperature and humidity levels:

1. Maximum and minimum temperatures inside, maximum or minimum relative humidity outside.

2. Maximum and minimum relative humidity inside, maximum or minimum relative humidity outside.

3. Maximum and minimum relative humidity inside, maximum or minimum temperature outside.

4. Maximum or minimum temperature inside, maximum or minimum temperature outside.

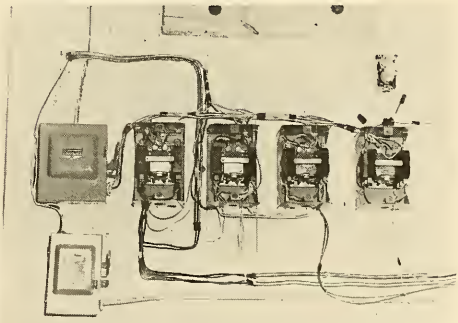


Figure 4– Master power panel for automatic ventilating door control.

There are many other possible combinations in temperature and relative humidity regulation of the ventilating doors in this four-control circuit. The system was so designed that two controls in parallel in this system would completely regulate the circuit when that particular parallel circuit was energized. The high and low humidity control circuit with sensing elements placed within the curing area, Figure 5, will control the operation of the doors until the third control circuit has been energized. At this stage the third control circuit will regulate the door operation until sensing elements of this parallel circuit have been de-energized by the changing temperature and humidity conditions.

An example of this operation would be where the high and low humidity level controls were placed within the tobacco barn curing area and the parallel circuit would include a humidity control, placed externally to the curing barn, in conjunction with a low-level temperature control placed inside the curing area. Humidity within the curing area would regulate the doors, opening and closing them, only until such time when the relative humidity of the incoming air exceeded a preset or desired control level or the temperature inside the curing area dropped below a prescribed level. If such occurred, the doors would close or remain closed regardless of the inside humidity until the relative humidity of the incoming air dropped below the preset level or the temperature within the barn was raised to the prescribed level.

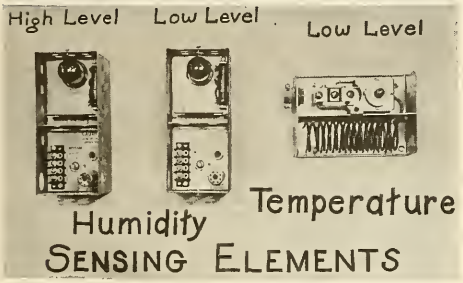


Figure 5– Humidity and temperature sensing elemenrs in automatic control circuit of ventilating doors.

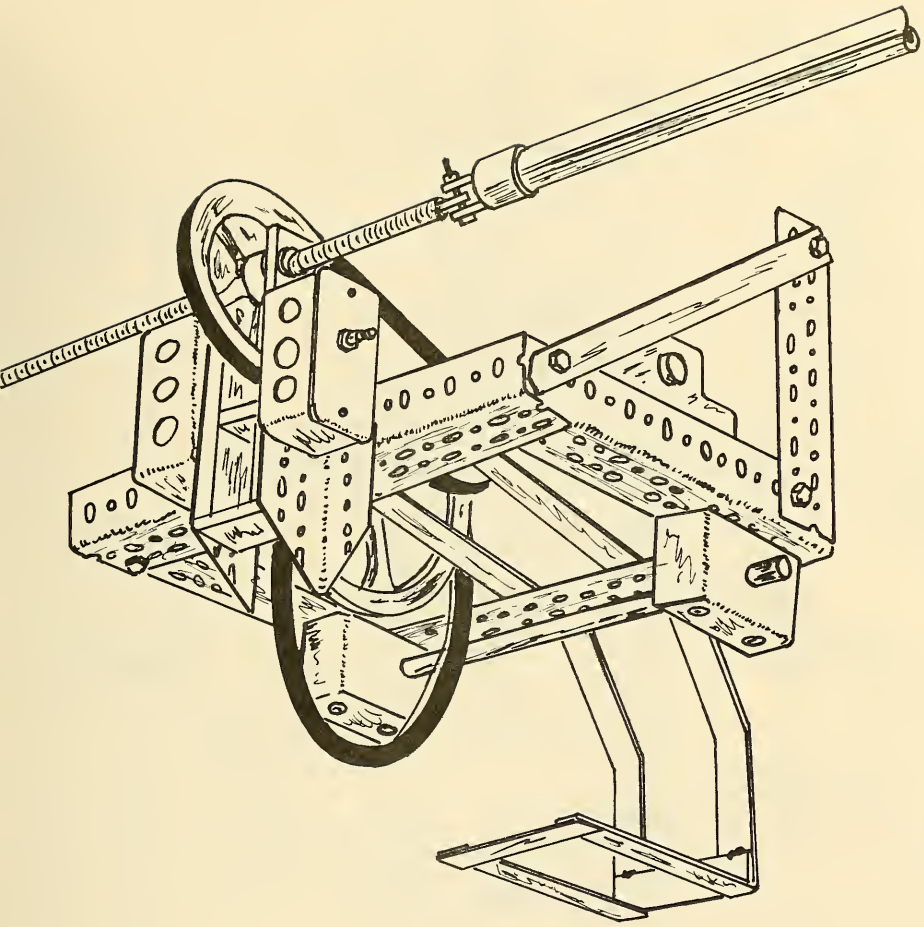
The investment in this electronic control system would be approximately $200.00; however, only one installation per curing structure would be necessary.

Conclusion

Manpower requirements in the processing and curing of burley tobacco are far greater than required for other related agricultural products. A large percentage of the labor requirements results from the type of structure used in the curing process of the tobacco. The automation of ventilating doors in the tobacco structure will, when installed, be a tremendous manpower saver as well as maintain more desirable curing conditions for the burley tobacco.

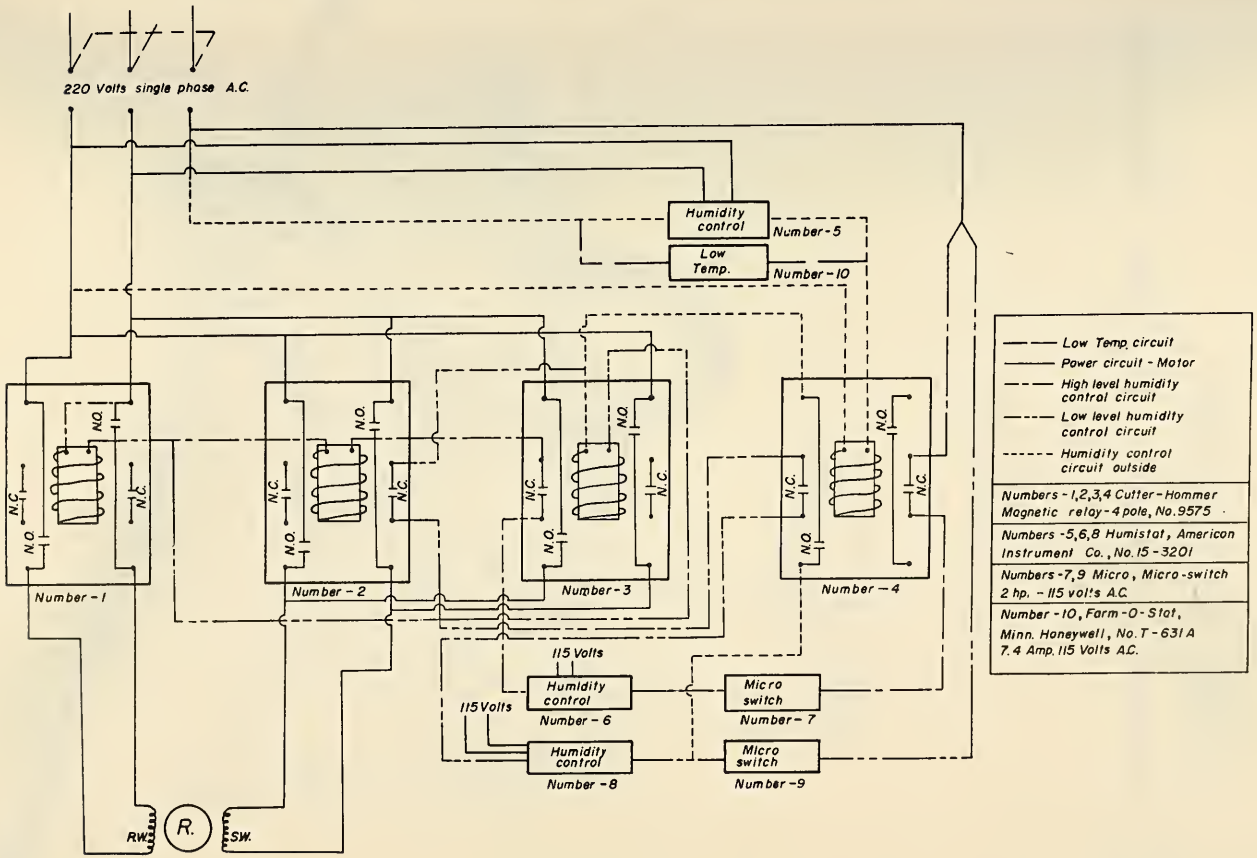
The elimination of the need for a man to manually control rhe operations of the ventilating doors during the curing season will, within a few years, pay for the mechanization of the ventilation system, which after the initial investment would cost only a few cents per day for operation. Better quality tobacco, yielding greater profits to the grower, will result from this automation program.

APPENDIX

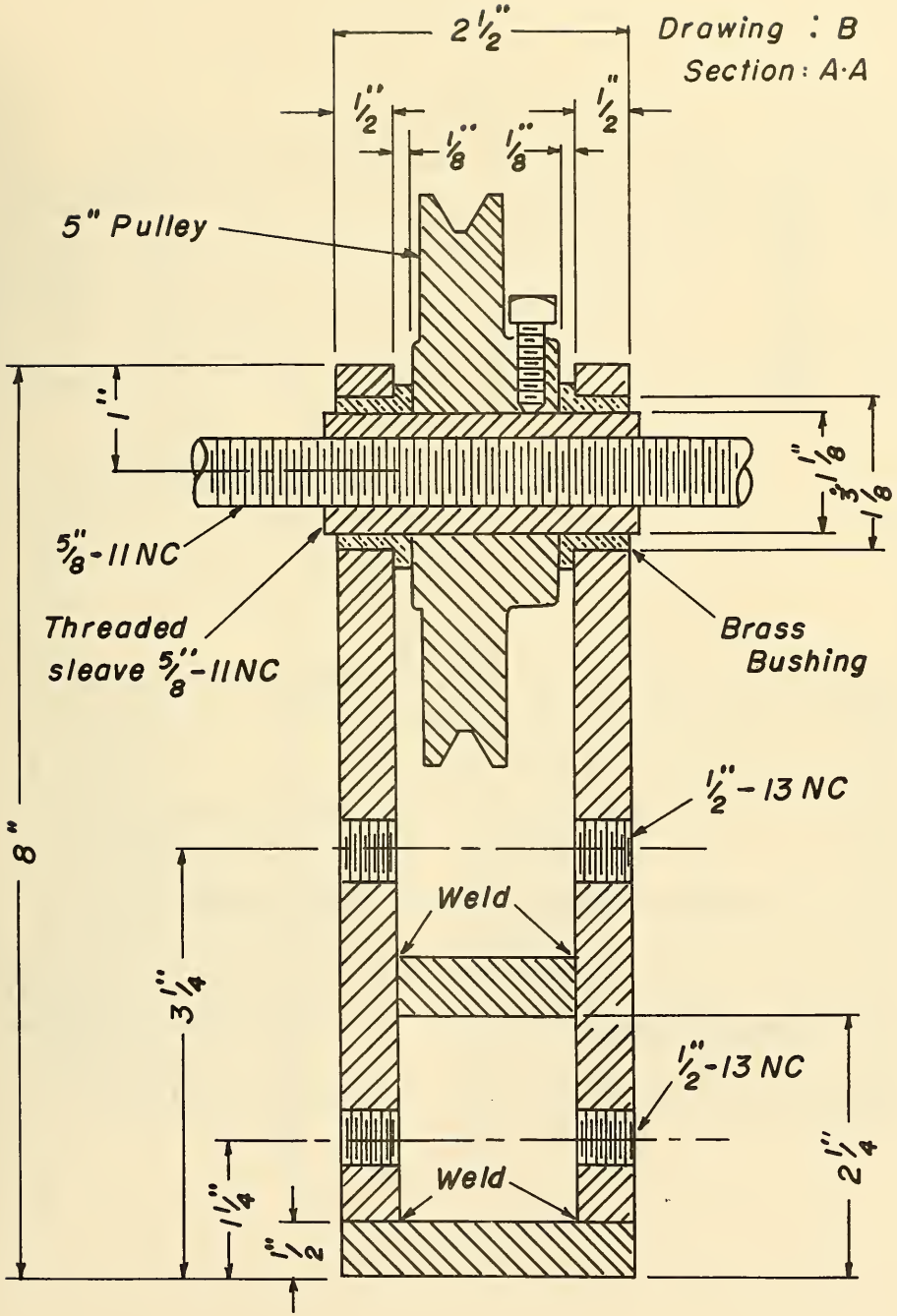


Drawing - A

Driving mechanism for tobacco barn ventilating doors



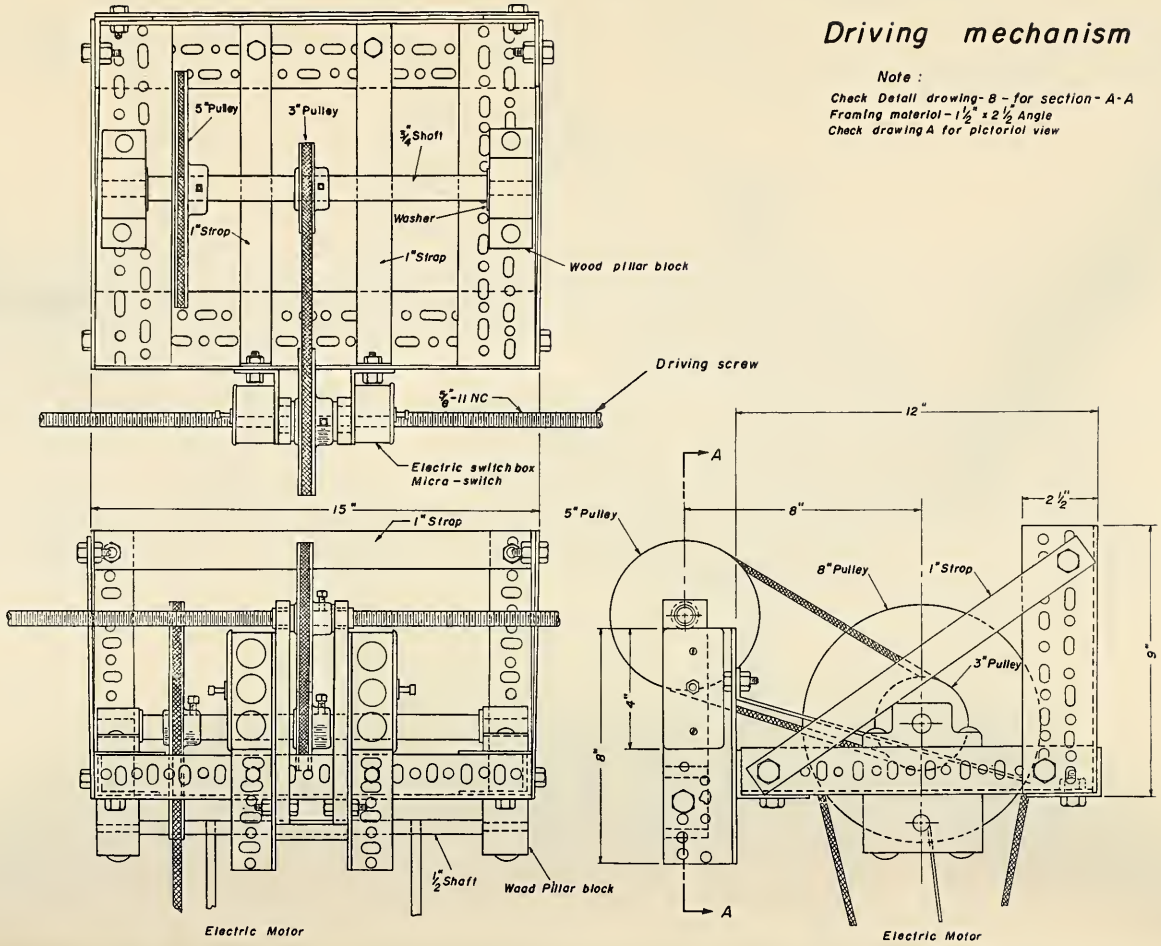
Control circuit for tobacco barn ventilating doors

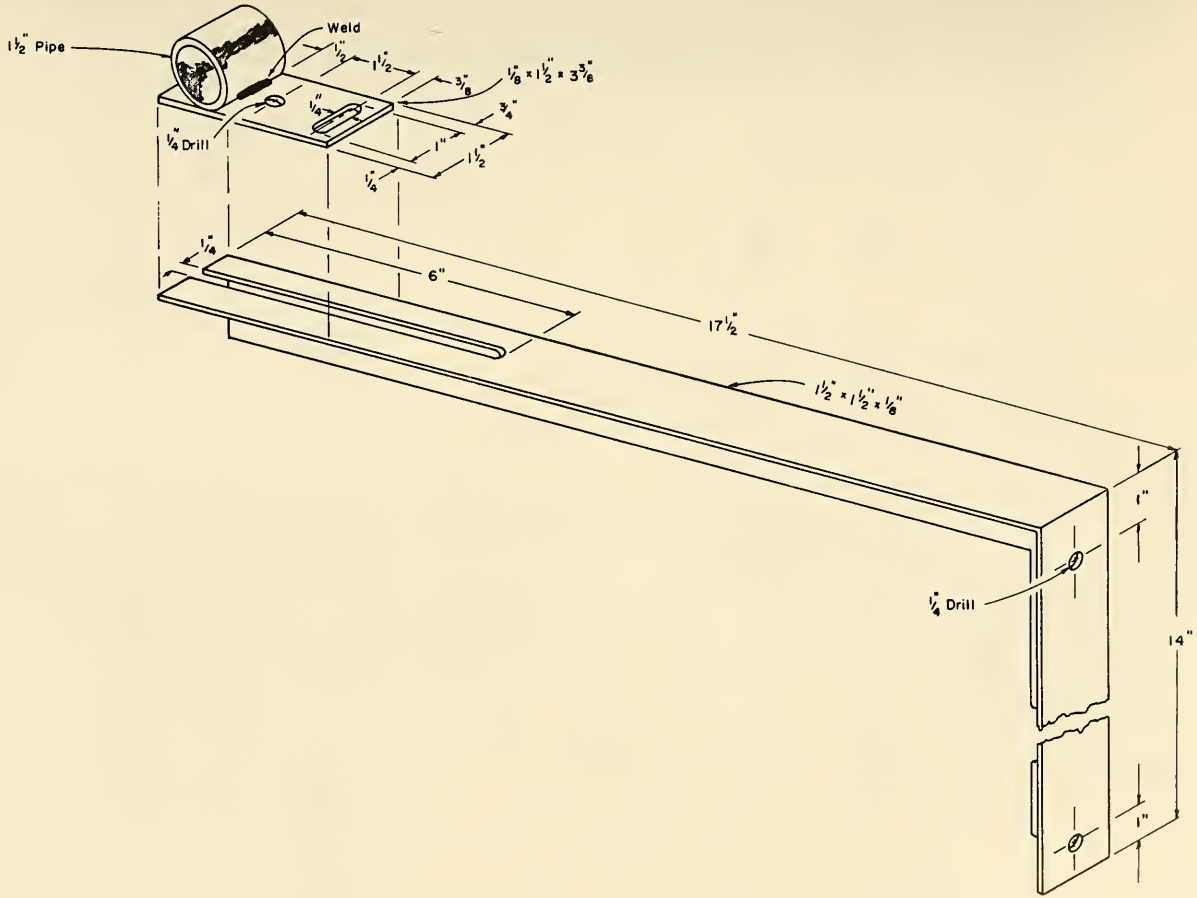

Drawing : B
Section : A-A
2 1/2"
1/2"
1/2"
1/8"
1/8"
5" Pulley
1"
1 1/8"
3 1/8"
5/8"-11NC
Threaded sleave 5/8"-11NC
Brass Bushing
1/2"-13 NC
8"
Weld
3 1/4"
1/2"-13 NC
2 1/4"
Weld
1 1/4"
1/2"

Driving mechanism

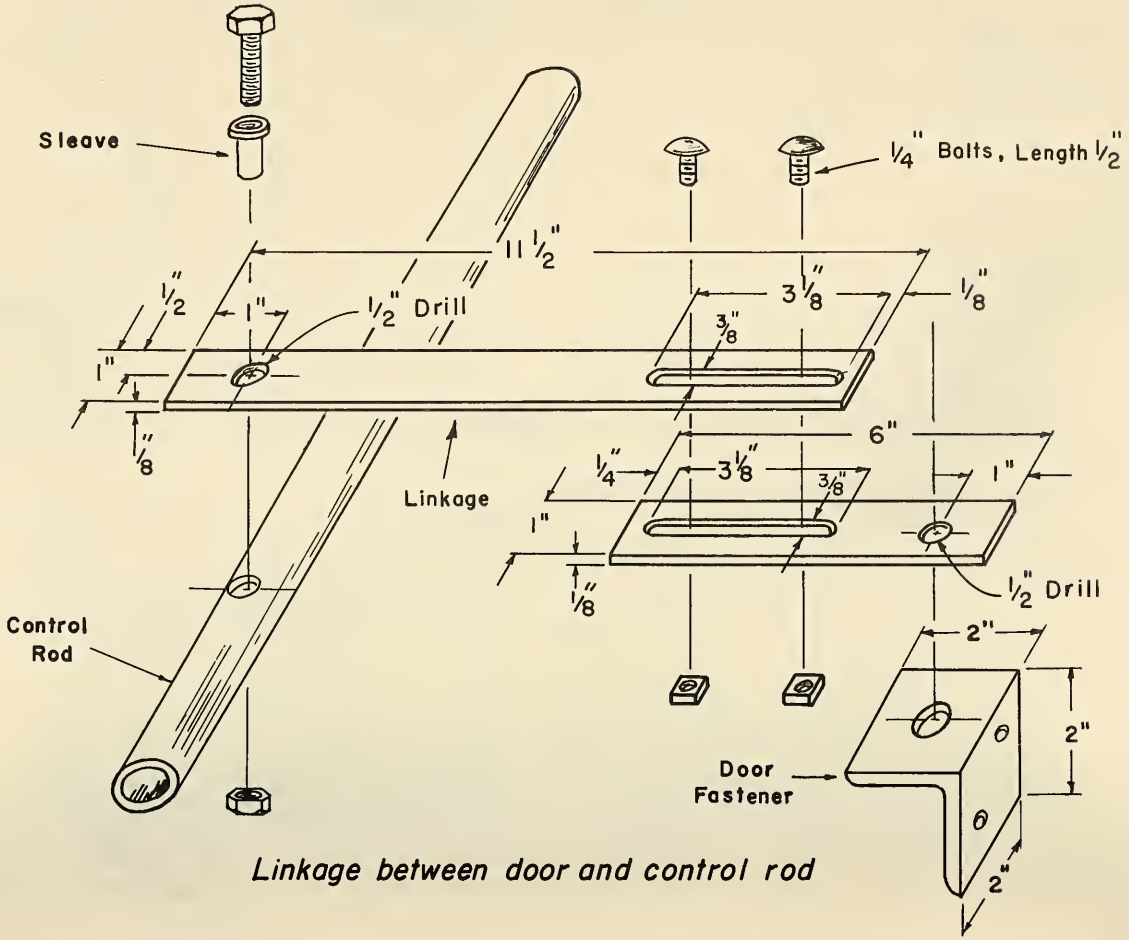
Note :

Check Detail drowing- B - for section - A-A
Framing materiol - 1½" x 2½" Angle
Check drawing A for pictoriol view

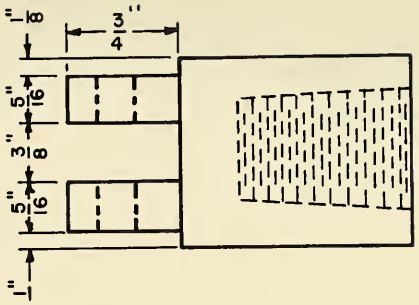


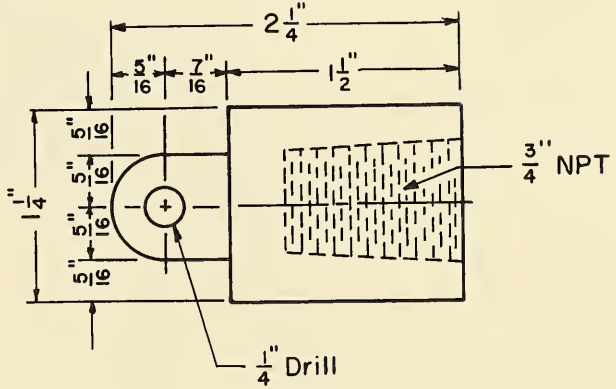


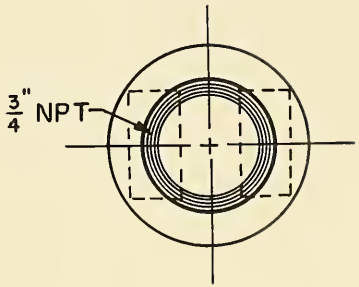
Control rod support



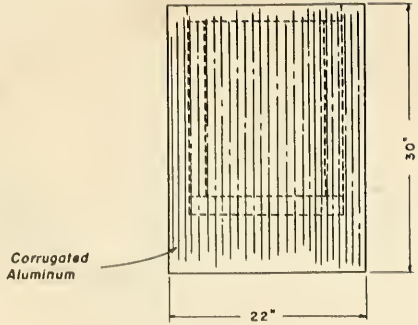
Linkage between door and control rod

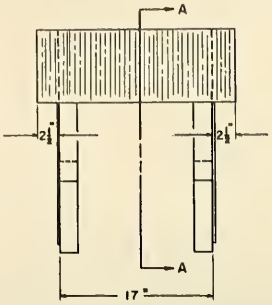


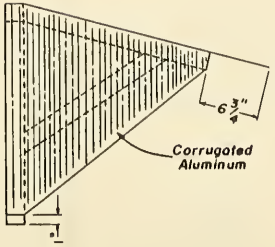


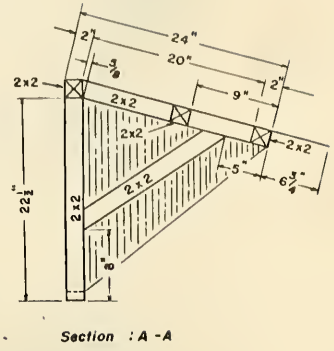


Coupling between driving screw and control rod









Section : A -A

Cover for driving mechanism